REMARKS

Amendments to the Specification

The specification of the application is amended to correct self-evident, typographical errors. No new matter has been added.

Amendments to the Claims

Claim 1 is amended to recite that the recited base layer is p-doped with carbon from an external carbon source to thereby have a carbon-dopant concentration in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3}. Support for this amendment can be found in originally-filed Claim 1 and in the specification, for example, on page 4, lines 18-20.

Claims 10 and 13 are amended to correct self-evident, typographical errors. Claim 13 is further amended to more clearly define the claimed invention. As amended, Claim 13 now recites that "the second transitional layer has a first surface contiguous with a surface of the base ···." Support for this amendment can be found in the specification, for example, on page 7, lines 7-10 and page 9, lines 19-21.

Objections to the Specification and Claims 10 and 13

The typographical errors on page 2, line 9 and on page 4, line 7 and line 8 that the Examiner noticed are corrected, as discussed above. Also, the typographical errors in Claims 10 and 13 that the Examiner noticed are corrected, as discussed above. Therefore, Applicants respectfully request that the Examiner withdraw these objections.

Rejection of Claim 13 under 35 U.S.C. § 112, second paragraph

Claim 13 is rejected under 35 U.S.C. 112, § second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regards as the invention. Claim 13 is amended to clarify that the second transitional layer has a first surface contiguous with a surface of the base. As amended, Claim 13 is now definite, particularly pointing out and distinctly claiming the subject matter which Applicants regards as

the invention. Accordingly, Applicants respectfully request reconsideration and withdrawal of this rejection.

Rejection of Claims 1-4 under 35 U.S.C. § 102(e)

Claims 1-4 are rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,765,242 B1 to Chang, *et al.* (hereinafter "Chang '242") The Examiner stated that Chang '242 discloses a method of fabricating a heterojunction bipolar transistor as claimed in independent Claim 1.

As amended, independent Claim 1 is directed to a method of fabricating a heterojunction bipolar transistor (HBT) that includes the step of growing a base layer comprising Ga, In, As and N from a Ga, In, As and N source, wherein the base layer is p-doped with carbon from an external carbon source to thereby have a carbon-dopant concentration in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3}.

Chang '242 discloses a double heterojunction bipolar transistor (DHBT) that includes a base region comprising a layer of p-type-doped InGaAsN sandwiched between n-type-doped collector and emitter regions. Although Chang '242 discusses that the InGaAsN base layer can be generally doped in the range of 10^{18}-10^{20} cm^{-3}, there is no disclosure or suggestion in Chang '242 of a carbon-dopant concentration in the InGaAsN base layer that is in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3}. Further, there is no disclosure or suggestion in Chang '242 of a method of growing a base layer that includes Ga, In, As and N and is carbon-doped in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3}.

Therefore, there is no disclosure or suggestion in Chang '242 of the subject matter of independent Claim 1, as amended. Accordingly, Claim 1 and Claims 2-4 dependent from Claim 1 are novel in view of Chang '242. Reconsideration and withdrawal of this rejection are respectfully requested.

Rejection of Claims 5-17 under 35 U.S.C. § 103(a)

Claims 5-17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Chang '242 in view of U.S. Patent Application Publication No. 2005/0020033 A to Specht, *et al.* (hereinafter "Specht, *et al.*")

Claims 5-17 are dependent from independent Claim 1. Claims 5-17 are thus directed to a method of fabricating an HBT, as recited in independent Claim 1, and further including the limitations recited in the respective claims.

As discussed above, although Chang '242 discusses a general doping concentration in the range of 10^{18}-10^{20} cm^{-3} for an InGaAsN base layer, Chang '242 does not disclose or suggest an InGaAsN base layer that is heavily carbon-doped in a range of between about 1.5 x 10^{19} cm^{-3} to about 7.0 x 10^{19} cm^{-3}. In particular, Chang '242 does not teach how to obtain a high carbon-dopant concentration in a range of between about 1.5 x 10^{19} cm^{-3} to about 7.0 x 10^{19} cm^{-3} while growing an InGaAsN base layer. Chang '242 only demonstrates that an InGaAsN base layer having the carbon-dopant concentration of 1 x 10^{19} cm^{-3} (see Table 1). Moreover, it had generally been known in 2000, when Chang '242 was filed, and when the provisional application was filed, of which the present application claims the benefit, that an InGaAsN base layer having a carbon-dopant concentration greater than 1 x 10^{19} cm^{-3} was difficult to achieve. For example, Chang *et al.* published in 2000, "InGaP/InGaAsN/GaAs *NpN* Double-heterojunction bipolar transistor," *Appl. Phys. Lett.*, 76 (16): 2262-2264 (2000) (Reference AX cited in the Information Disclosure Statement filed August 13, 2004), states:

> [T]he base doping (N_{ab}) in our devices is ***1 x 10^{19} cm^{-3}, lower than the typical mid-10^{19} cm^{-3} of N_{ab} used in the InGaP/GaAs HBTs***, (page 2264, column 2, lines 2-4, emphasis added)

> However, ***due to the limitation of the InGaAsN material available today***, the R_B is still high, causing the V_{offset} and the V_{sat} to be high. Further improvements on the InGaAsN material ***are still necessary to reduce R_B and improve β*** [collector current gain] so that the full potential of InGaAsN for low-power applications can be realized." (page 2264, column 2, lines 21-26, emphasis added).

As indicated in the present specification on page 14, lines 23-24, maintaining high-p-type doping levels as indium and nitrogen are added to carbon-doped GaAs is not trivial. The DHBTs prepared according to the Applicants' claimed invention, having carbon dopant levels of greater than 2.5 x 10^{19} cm^{-3}, resulted in a low base sheet resistivity of 300 Ω/square, good electron

mobility of about 85 cm^2/V-s and a dc collector current gain (β) of ***greater than 60*** (see, for example, page 10, line 29 through page 11, line 4).

Chang '242 does not disclose or suggest that an HBT having an InGaAsN base layer that is heavily carbon-doped in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3} can result in low base sheet resistivity, good electron mobility across the base layer and high collector current gain. The DHBT of Chang, *et al.* shows a dc collector current gain (β) of only ***23***. (see FIG. 5 and Column 15, lines 29-36 of Chang '242), as opposed to Applicants' dc collector current gain of greater than 60, recited above. Applicants' claimed methods of fabricating an HBT were not predicted by the teachings of Chang '242. Therefore, Chang '242 does not render Applicants' claimed methods of fabricating an HBT obvious, where the base layer includes Ga, In, As and N and is carbon-doped in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3} from an external carbon source.

Specht, *et al.* disclose a method of depositing beryllium (Be)-doped GaAs thin film at a low temperature that typically ranges from approximately 200 °C to approximately 400 °C. (LT-GaAs: see, for example, the abstract and [0043] of Specht, *et al.*) However, there is no disclosure or suggestion in Specht, *et al.* of a method of depositing an InGaAsN base layer. As clearly discussed in [0009], lines 17-25, the teachings of Specht, *et al.* are limited to ternary alloys of III-V compounds derived from GaAs, and do not extend to quaternary alloys, such as InGaAsN. Moreover, there is no teaching in Specht, *et al.* of growing an InGaAsN base layer doped with carbon in a range of between about 1.5×10^{19} cm^{-3} to about 7.0×10^{19} cm^{-3}. As such, Specht, *et al.* do not remedy the deficiencies of Chang '242.

Therefore, Applicants' invention of Claims 5-17 is non-obvious in view of Chang '242. and Specht, *et al.*, taken either separately or in combination. Applicants respectfully request that the Examiner reconsider and withdraw this rejection.

Information Disclosure Statement

The Examiner noticed that the Information Disclosure Statement filed August 13, 2004 cited twice the same reference, U.S. 6,150,677, referencing to different inventor's names, Tanaka *et al.* and Ishizaka *et al.* Applicants acknowledge the error and confirm that the correct inventor's name for U.S. 6,150,677 is Tanaka *et al.*

SUMMARY AND CONCLUSIONS

As discussed above, Claims 1-17, as currently presented, are novel and non-obvious in view of Chang '242 and Specht, *et al.* Claim 13, as amended, is now definite, meeting the requirements of 35 U.S.C. § 112 , second paragraph. Thus, in view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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